

- 12 -

C L A I M S

1. A process for controlling the performance of a homogeneous charge compression (HCCI) engine in a vehicle having a hydrocarbon fuel reservoir which process comprises adjusting the octane or cetane number of hydrocarbon fuel being supplied to the HCCI engine by:

- (a) converting a portion of hydrocarbon fuel from the hydrocarbon fuel reservoir to synthesis gas;
- (b) converting synthesis gas produced in step (a) to a mixture of hydrocarbons having an octane number less than or a cetane number higher than that of the hydrocarbon fuel of the hydrocarbon fuel reservoir using a Fischer Tropsch process;
- (c) delivering (i) a portion of hydrocarbon fuel from the hydrocarbon fuel reservoir and (ii) a portion of the mixture of hydrocarbons produced in step (b) to the HCCI engine; and
- (d) varying the amounts of (i) and (ii) in step (c) in order to adjust the octane or cetane number of the hydrocarbon fuel being supplied to the HCCI engine.

2. A process according to claim 1 or claim 2 wherein at least part of the water required for step (a) is obtained by condensing an exhaust gas stream from the engine or vehicle.

3. A process according to any one of the preceding claims wherein the synthesis gas used in step (b) has a hydrogen gas to carbon monoxide ratio in the range of 0.6 to 2.5 part hydrogen gas for every part carbon monoxide.

- 13 -

4. A process according to any one of the preceding claims wherein heat of reaction from the Fischer Tropsch process of step (b) is used to:

- 5 (i) provide heat for the reaction of step (a) of claim 1; and/or
(ii) preheat the reactants for the reaction of step (a) of claim 1.

10 5. A process according to any one of the preceding claims wherein the Fischer Tropsch process in step (b) is followed by a condensing step which produces a light and a heavy fraction and wherein the light and/or the heavy fraction form at least part of the mixture of hydrocarbons in (ii) of step (c) of claim 1.

15 6. A process according to claim 5 wherein the condensing step produces a light fraction and a heavy fraction and at least a part of the light fraction is either

- 20 (a) stored in a pressurised storage container;
(b) delivered to the HCCI engine; or
(c) recycled by converting it to synthesis gas in step (a) of claim 1.

7. A process according to claim 5 or claim 6 wherein cooling water for the condensing step is provided by a cooling system for the HCCI engine or vehicle.

25 8. A process according to any one of the preceding claims which process further comprises monitoring the performance of the HCCI engine using a sensor to provide information relating to engine performance and adjusting the octane number or cetane number in response to said
30 information.

9. A process according to claim 8 wherein the sensor is a knock sensor.

- 14 -

10. A process according to claim 8 or claim 9 wherein an engine management chip receives information from the sensor and processes said information to provide data from which the required amounts of (i) and (ii) of step
5 (c) in the process of claim 1 can be determined.
11. A HCCI engine and fuel system comprising
- (a) a fuel reservoir;
 - (b) a HCCI engine;
 - (c) a reformer for converting hydrocarbon fuel to
10 synthesis gas;
 - (d) a reactor for converting synthesis gas to a hydrocarbon mixture using a Fischer Tropsch process;
 - (e) means for removing a portion of hydrocarbon fuel from the fuel reservoir and delivering it to the
15 reformer;
 - (f) means for removing synthesis gas product from the reformer and delivering it to the reactor;
 - (g) means for removing a mixture of hydrocarbons from the Fischer Tropsch reactor and delivering it to the
20 HCCI engine; and
 - (h) means for removing a portion of hydrocarbon fuel from the fuel reservoir and delivering it to the HCCI engine.
12. A HCCI engine and fuel system according to claim 11
25 which further comprises a condenser for converting a hydrocarbon mixture produced by the reactor into a light and a heavy fraction; and the means specified in (g) includes means for removing a portion of the heavy fraction and/or the light fraction produced by the
30 condenser and delivering it to the HCCI engine.
13. A HCCI engine and fuel system according to claim 11 or claim 12 comprising a sensor for monitoring the engine's performance.

- 15 -

14. A HCCI engine and fuel system according to claim 13 comprising an engine management chip.

15. A HCCI engine and fuel system according to any one of claims 11 to 14 which further comprises one or more
5 of:

- (a) a pressurised storage container for storing the light fraction produced by the condenser;
- (b) a trap for removing sulphur from the synthesis gas being fed into the Fischer Tropsch reactor; and
- 10 (c) a hydrogen removal unit for removing hydrogen from the synthesis gas product from the reformer before the synthesis gas is fed to the Fischer Tropsch reactor.

16. A vehicle comprising the HCCI and fuel system of
5 claims 10 to 15.